

OVERVIEW

UNBREAKABLE

➤ Building the Resilience of the Poor in the
Face of Natural Disasters



WORLD BANK GROUP

Stephane Hallegatte
Adrien Vogt-Schilb
Mook Bangalore
Julie Rozenberg

OVERVIEW

UNBREAKABLE



Building the Resilience of the Poor in the
Face of Natural Disasters

Stephane Hallegatte
Adrien Vogt-Schilb
Mook Bangalore
Julie Rozenberg

This booklet contains the overview, as well as a list of contents, from *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters* (doi: 10.1596/978-1-4648-1003-9). A PDF of the final, full-length book, once published, will be available at <https://openknowledge.worldbank.org/> and print copies can be ordered at <http://Amazon.com>. Please use the final version of the book for citation, reproduction, and adaptation purposes.

© 2017 International Bank for Reconstruction and Development / The World Bank
1818 H Street NW, Washington, DC 20433
Telephone: 202-473-1000; Internet: www.worldbank.org
Some rights reserved

This work is a product of the staff of The World Bank with external contributions. The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of The World Bank, its Board of Executive Directors, or the governments they represent. The World Bank does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Nothing herein shall constitute or be considered to be a limitation upon or waiver of the privileges and immunities of The World Bank, all of which are specifically reserved.

Rights and Permissions



This work is available under the Creative Commons Attribution 3.0 IGO license (CC BY 3.0 IGO) <http://creativecommons.org/licenses/by/3.0/igo>. Under the Creative Commons Attribution license, you are free to copy, distribute, transmit, and adapt this work, including for commercial purposes, under the following conditions:

Attribution—Please cite the work as follows: Hallegatte, Stephane, Adrien Vogt-Schilb, Mook Bangalore, and Julie Rozenberg. 2017. “Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters.” Climate Change and Development Series. Overview booklet. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

Translations—If you create a translation of this work, please add the following disclaimer along with the attribution: This translation was not created by The World Bank and should not be considered an official World Bank translation. The World Bank shall not be liable for any content or error in this translation.

Adaptations—If you create an adaptation of this work, please add the following disclaimer along with the attribution: *This is an adaptation of an original work by The World Bank. Views and opinions expressed in the adaptation are the sole responsibility of the author or authors of the adaptation and are not endorsed by The World Bank.*

Third-party content—The World Bank does not necessarily own each component of the content contained within the work. The World Bank therefore does not warrant that the use of any third-party-owned individual component or part contained in the work will not infringe on the rights of those third parties. The risk of claims resulting from such infringement rests solely with you. If you wish to re-use a component of the work, it is your responsibility to determine whether permission is needed for that re-use and to obtain permission from the copyright owner. Examples of components can include, but are not limited to, tables, figures, or images.

All queries on rights and licenses should be addressed to World Bank Publications, The World Bank Group, 1818 H Street NW, Washington, DC 20433, USA; e-mail: pubrights@worldbank.org.

Cover design: Brad Amburn Creative, LLC

Library of Congress Cataloging-in-Publication Data has been requested.

CONTENTS OF “UNBREAKABLE: BUILDING THE RESILIENCE OF THE POOR IN THE FACE OF NATURAL DISASTERS”

Acknowledgments	ix
Overview	1
1. Introduction: Natural hazards and poverty.....	19
2. On the front line: Poor people suffer disproportionately from natural hazards	25
Poor people are more often affected by natural hazards.....	26
Poor people lose more when hit by a disaster	41
Poor people receive less support to cope and recover.....	51
3. Vicious circles: Natural disasters keep people in poverty.....	63
Disasters have visible impacts on poverty	64
Disasters increase poverty by reducing economic growth	66
Disasters also affect poverty directly, even in the absence of visible impacts on GDP	71
Natural disasters—especially floods and drought—have a significant impact on the global poverty headcount	74
Recurrent risk reduces incentives to invest and keeps people in poverty	77
4. A diagnosis: The global impacts of natural disasters on well-being are underestimated ..	87
The impact of the 2005 floods in Mumbai on well-being, and options for action, can be estimated.....	89
A simple model provides estimates of risk to well-being and socioeconomic resilience in 117 countries....	93
In all countries, the impacts of natural disasters on well-being are larger than asset losses.....	96
Our estimate captures only partially the many dimensions of resilience	100
Resilience can also be measured at the provincial level: Vietnam.....	104
5. Avoiding disasters: Well-being losses can be mitigated by reducing asset losses.....	111
Several policies can reduce exposure to disasters.....	112
Opportunities are also on hand to reduce the vulnerability of people's assets to natural disasters	124
6. Managing what cannot be avoided: Risk can be reduced by improving resilience.....	135
Better financial inclusion increases resilience and reduces the impacts of disasters on well-being.....	137
Insurance can play a key role	142
Poor people can be protected by social protection systems	148
The solution: Combining disaster risk reduction and a global resilience package to reduce the impact of disasters on well-being.....	166
7. Tailor-made: Policy priorities can be identified at the country level	175
Country-level disaster management profiles help identify promising policies.....	177
Summing up	184
Appendix: Study results for 117 countries.....	185

ACKNOWLEDGMENTS

This report was written by a team led by Stephane Hallegarte and composed of Mook Bangalore, Julie Rozenberg, and Adrien Vogt-Schilb. It benefited from contributions by Laura Bonzanigo, Shun Chonabayashi, Martin Heger, Steffen Lohrey, Christian Lovell, Ulf Narloch, and Emily Jennifer White. The team thanks Scott Vincent Andrews, Aziz Gokdemir, Patricia Katayama, Shaela Rahman, and David Charles Tucker for their help in the preparation of the report, and to Francis Ghesquiere, manager of the Global Facility for Disaster Reduction and Recovery who initiated and supported this project.

Guidance was provided by the report's peer reviewers. Internal peer reviewers included Carter Brandon, Niels B. Holm-Nielsen, Alanna Simpson, Emmanuel Skoufias, and Ruslan Yemtsov. Ilan Noy, Professor of Economics at Victoria University of Wellington, New Zealand, also provided invaluable comments and suggestions.

For important contributions and advice, the team thanks Abby Baca, Henrike Brecht, Daniel Jonathan Clarke, Christophe Crepin, Carlo del Ninno, Marianne Fay, Julien Gagneur, Rashmin Gunasekera, Steve Hammer, Maddalena Honorati, Oscar A. Ishizawa, Abhas K. Jha, Jolanta Kryspin-Watson, Barry Patrick Maher, Olivier Mahul, Samuel Munzele Maimbo, Juan Jose Miranda, Rick Murmane, Israel Osorio-Rodarte, Artessa Saldivar-Sali, Zuzana Stanton-Geddes, and the World Bank's Geospatial Operations Support Team, and especially Keith Garrett. The authors also thank Ted Veldkamp, from VU University in Amsterdam, and the United Nations' International Strategy for Disaster Risk Reduction team, and especially Gabriel A. Bernal, Mabel Cristina Marulanda, Andrew Maskrey, and Sahar Safaie.

Detailed comments on drafts of this report and on the background papers were provided by Paolo Bazzurro, Charlotte Benson, David Bevan, Sebastian Boreux, Jinqiang Chen, Patrice Dumas, Nate Engle, Chico Ferreira, Chris Field, Francis Ghesquiere, Ruth Hill, Kazuko Ishigaki, Brenden Jongman, Tamaro Kane, Kouassi Kouadio, Norman Loayza, Hugh MacLeman, Reinhard Mechler, Martin Melecky, James Newman, James Orr, Richard Poulter, Valentin Przyluski, Rob Reid, Adam Rose, Rae Rosen, Vladimir Stenek, Tse-Ling The, Maarten van Aalst, Claudio Volonte, and Sebastian von Dahlen. Useful comments were also received from participants of the 2015 Disaster Risk Financing and Insurance workshop organized by FERDI, CERDI, and GFDRR in Clermont-Ferrand, France; the GFDRR's 2016 Understanding Risk Conference in Venice, Italy; and the 2016 ENGAGE workshop hosted by the Potsdam Institute for Climate Impact Research in Berlin, Germany.

Editorial services were provided by Sabra Ledent and Paul Holtz. Brad Amburn designed the report. Visibility and launch of the report were supported by Elisabeth Mealey, Scott Vincent Andrews, Lisa Thalheimer, Nicholas James Parker, Gayle Young, Peter Vincent Von Elling, Edgar Buckley, Nicholas Andrew Keyes, Gerardo Spatuzzi, Camila Perez, and Shaela Rahman.

The report was sponsored by the Global Facility for Disaster Reduction and Recovery (GFDRR) and the Climate Change Cross-Cutting Solutions Area of the World Bank, under the leadership of John Roome.



OVERVIEW



**Building the resilience of the poor
in the face of natural disasters.**

Economic losses from natural disasters totaled \$92 billion in 2015, and average annual losses have been estimated at more than \$300 billion a year.¹ Policy makers, analysts, and others are used to such statements, which measure the severity of disasters and their socioeconomic impacts using the value of the damages inflicted by disasters on buildings, infrastructure, equipment, and agricultural production.

Although these numbers are useful—they provide information on the trends and costs of disasters—they fail to detail how disasters affect people's well-being. Obviously, \$1 in losses does not mean the same thing to a rich person and a poor person, and the severity of a \$92 billion loss depends on who experiences it. The same loss affects poor and marginalized people far more because their livelihoods depend on fewer assets, their consumption is closer to subsistence levels, they cannot rely on savings to smooth the impacts, their health and education are at greater risk, and they may need more time to recover and reconstruct. A flood or earthquake can be disastrous for poor people, but have a negligible impact on a country's aggregate wealth or production if it affects people who own almost nothing and have very low incomes. By focusing on aggregate losses, the traditional approach examines how disasters affect people wealthy enough to have wealth to lose and so does not take into account most poor people.

This shortcoming is not just a monitoring issue. When projects to reduce disaster risk are assessed on the basis of the value of damages that can be avoided, analyses favor projects that will protect or support richer areas or people. Imagine two flood protection projects with similar costs. The first would cover a wealthy neighborhood in a capital city. Because of the density of high-value assets, it would avert on average \$10 million a year in damages. The second project would target poorer areas in a second-tier city and prevent just \$5 million a year in losses. A traditional analysis would unambiguously select the first project. But a \$5 million loss may matter more to poor people than a \$10 million loss to richer people. If the second project benefits very poor people, it may generate greater benefits for well-being. And because well-being is the ultimate goal of public policy, the second project may be more attractive.

Moreover, not all risk management policies can be assessed using metrics that include only asset and production losses. Policies such as increasing access to financial services and expanding social safety nets make it easier for people to absorb, cope with, and recover from damages caused by natural disasters. Thus such policies can mitigate the impact of natural disasters on well-being even though they have no impact on direct damages from disasters.

This report moves beyond asset and production losses and focuses instead on how natural disasters affect people's well-being. Here, natural disaster risk and losses are measured using a metric that can capture their overall effects on poor and nonpoor people, even if the economic losses of poor people are small in absolute terms. This metric can be used in the analysis of disaster risk management projects so that investments improve the well-being of all people and are not systematically driven toward wealthier areas and individuals. And this report proposes and uses a consistent framework to assess traditional approaches to reducing disaster risk (such as building dikes or reinforcing building regulations) and strengthening resilience (such as adopting adaptive social safety nets) to help design consistent risk management policies.

By examining well-being instead of asset losses, this report provides a deeper (and grimmer) view of natural disasters than does the usual reporting—indeed, this view takes better account of poor people's vulnerability. This analysis also identifies opportunities for action and policy priorities at the country level, with three main messages:

1. Efforts to reduce poverty and disaster risks are complementary. Estimates for 89 countries find that if all natural disasters could be prevented next year, the number of people in extreme poverty—those living on less than \$1.90 a day—would fall by 26 million. The impact on poverty is large because poor people are exposed

to hazards more often, lose more as a share of their wealth when hit, and receive less support from family and friends, financial systems, and governments. In fact, disasters can push people into poverty, and so disaster risk management can be considered a poverty reduction policy. And since poverty reduction policies make people less vulnerable, they can be considered part of the disaster risk management toolbox.

2. Natural disasters affect well-being more than what traditional estimates suggest.

Poor people suffer only a small share of the economic losses caused by disasters, but they suffer disproportionately. Based on estimates of *socioeconomic resilience* in 117 countries, and including in the analysis how poverty and lack of capacity to cope with disasters magnify losses in well-being, the effects of floods, wind storms, earthquakes, and tsunamis on well-being are equivalent to a \$520 billion drop in consumption—60 percent more than the widely reported asset losses. The design of disaster risk management should, then, not rely only on asset losses. Targeting poorer people with disaster risk reduction interventions—such as dikes and drainage systems—would generate lower gains in avoided asset losses but larger gains in well-being.

3. Policies that make people more resilient—and so better able to cope with and recover from the consequences of disasters that cannot be avoided—can save \$100 billion a year.

Action on risk reduction has a large potential, but not all disasters can be avoided. Expanding financial inclusion, disaster risk and health insurance, social protection and adaptive safety nets, contingent finance and reserve funds, and universal access to early warning systems would also reduce well-being losses from natural disasters. If all countries implemented these policies in the proposed “resilience package,” the gain in well-being would be equivalent to a \$100 billion increase in annual global consumption.

Efforts to reduce poverty and disaster risks are complementary

Natural disasters keep or move people back into poverty and are one reason that eradicating poverty is so difficult. Between 2006 and 2011, 45 percent of poor households in Senegal escaped poverty, but 40 percent of nonpoor households fell into it, leaving the poverty rate almost unchanged. Natural risk contributed to this lack of progress: households affected by a natural disaster were 25 percent more likely to fall in poverty during the period (Dang, Lanjouw, and Swinkels 2014). Among Guatemalan households hit by tropical storm Agatha in 2010, per capita consumption fell 5.5 percent, increasing poverty by 14 percent (Baez et al. 2016). After Ethiopia’s 1984–85 famine, it took a decade for most asset-poor households to restore livestock holdings to pre-famine levels (Dercon 2004).

Poor people suffer disproportionately from natural hazards. Natural disasters hit poor people particularly hard for five reasons:

Overexposure. Poor people are overexposed to floods in many countries, such as in Panama and Zimbabwe, where they are greater than 50 percent more likely than the average to be flooded. Such overexposure is also true for drought and high temperatures in most countries. More important, poor people are often exposed to frequent, low-intensity events, such as the recurrent floods that affect many cities with insufficient drainage infrastructure. These events do not attract media interest and are poorly documented, but they can have significant cumulative impacts, especially through their effects on health.

Higher vulnerability. People's vulnerability—that is, how much they lose when they are hit—is also a critical determinant of the impacts of natural disasters. When poor people are affected, the share of their wealth lost is two to three times that of the nonpoor, largely because of the nature and vulnerability of their assets and livelihoods. A global analysis suggests that poor people are nearly twice as likely to live in fragile dwellings.

Less ability to cope and recover. The impact of natural disasters on well-being also depends on how well people cope and recover, which depends on the support they receive. Coverage of poor people by social protection is often low. And after they are hit by a shock, poor people receive less postdisaster support than do nonpoor people. For example, in response to the floods and landslides in Nepal in 2011, only 6 percent of the very poor sought government support, compared with almost 90 percent of the well-off (Gentle et al. 2014).

Permanent impacts on education and health. Disasters force poor households to make choices that have detrimental long-term effects, such as withdrawing a child from school or cutting health care expenses. In such cases, children are often the main victims (Kousky 2016). In Guatemala, Storm Stan increased the probability of child labor by more than 7 percent in areas hit by the storm (Bustelo 2011). In Ethiopia, children under 3 at the height of the 1984 famine were less likely to eventually complete primary school, leading to income losses of 3 percent (Dercon and Porter 2014). And in Peru, the impacts of the 1970 Ancash earthquake on educational attainment can be detected even for the children of mothers affected at birth, demonstrating that the effects of large disasters can extend even to the next generation (Caruso and Miller 2015). Irreversible effects on education and health can reinforce the intergenerational transmission of poverty.

Effects of risk on saving and investment behavior. The losses the poor suffer are not the only way in which disasters and natural risks keep them in poverty. Sometimes, the impact exists even before the disaster hits (ODI and GFDRR 2015). For example, smallholders tend to plant low-return, low-risk crops because they cannot afford to lose one year of production in case of bad weather, so their income is reduced even when the weather is good (Cole et al 2013). And people are less likely to invest in their house or production equipment if these investments are likely to be washed away by a flood.

Natural disasters increase global poverty

Poverty is thus a factor in the vulnerability to disasters. Similarly, disasters are a driver of poverty. Although it remains impossible to quantify the full effect of natural disasters on the number of impoverished, it is possible to assess the short-term impacts of income losses (see Rozenberg and Hallegatte forthcoming). To do so, a counterfactual scenario was built of what people's income would be in developing countries in the absence of natural disasters. This scenario uses surveys of 1.4 million households, which are representative of 1.2 billion households and 4.4 billion people in 89 countries. The analysis concludes that if all disasters could be prevented next year, 26 million fewer people would be in extreme poverty—that is, living on less than \$1.90 a day. Although this estimate is subject to large uncertainties and cannot capture all impacts, including those on health, education, and savings, it still shows how severely natural hazards affect poverty.

Vulnerability to natural hazards and disasters can be reduced through development and poverty reduction efforts that enable people to settle in safer places, make their livelihoods and assets less vulnerable, and provide them with the tools and support needed to cope with shocks. Thus policies that help reduce poverty can be considered part of the disaster risk management toolbox. But the connection between poverty and disaster risk goes both ways: disasters make it harder for poor people to escape poverty. Disaster risk management can thus also be considered a poverty reduction policy.

Natural disasters affect well-being more than most people think

For hazards such as floods, storms, tsunamis, and earthquakes, risk assessment typically focuses on:

- » Hazard—the probability of an event occurring
- » Exposure—the population and assets located in an affected area.
- » Asset vulnerability—the value lost when an asset is affected by a hazard.

These three factors constitute the *risk to assets*—that is, the average monetary value of the damages that disasters inflict on assets (often measured as replacement or repair value). But the risk to assets is an incomplete metric.

This report extends risk assessment to measure the well-being losses caused by natural disasters (figure O.1). To do so, risk assessment was conducted separately for poor and nonpoor people, defined as the bottom 20 percent and the top 80 percent in terms of consumption in each country. The analysis takes into account the various dimensions of inequality of poor and nonpoor people in the face of disasters and the distribution of losses across individuals. Indeed, losses concentrated on fewer or poorer individuals have a larger impact than the same losses affecting richer people or shared across larger populations.

Figure O.1: This report moves beyond asset losses to estimate how natural disasters affect well-being



Specifically, the analysis considers the different abilities of poor and nonpoor people to cope with asset losses by modeling the effects of asset losses on income (accounting for capital productivity and diversification of income sources) and consumption (accounting for savings, remittances and social protection, and postdisaster transfers). Consumption losses are translated into well-being losses, taking into account the different impacts of a \$1 loss on poor and nonpoor individuals. Well-being loss at the country level depends on the distribution of impacts within the population, but it is expressed as the equivalent loss in national consumption. Thus a finding that a disaster causes \$1 million in well-being losses means that the impact of a disaster on well-being is equivalent to a \$1 million decrease in country consumption, perfectly shared across the population.

Socioeconomic resilience measures an economy's ability to minimize the impact of asset losses on well-being. It can be defined as the ratio of *asset losses* to *well-being losses*:

$$\text{socioeconomic resilience} = \frac{\text{asset losses}}{\text{well-being losses}}$$

If socioeconomic resilience is 50 percent, then well-being losses are twice as large as asset losses—that is, \$1 in asset losses from a disaster is equivalent to \$2 in consumption losses, perfectly shared across the population. Socioeconomic resilience can be considered a driver of the *risk to well-being*, along with the three usual drivers of risk assessment:

$$\text{Risk to well-being} = \frac{\text{expected asset losses}}{\text{socioeconomic resilience}} = \frac{(\text{hazard}) \cdot (\text{exposure}) \cdot (\text{asset vulnerability})}{\text{socioeconomic resilience}}$$

The impacts of natural disasters on well-being are larger than asset losses

In all of the 117 countries studied, well-being losses from natural disasters are larger than asset losses (Hallegatte, Bangalore, and Vogt-Schilb, forthcoming). According to the *United Nations Global Assessment Report on Disaster Risk Reduction*—the so-called GAR (UNISDR 2015)—total asset losses from natural disasters in these countries average \$327 billion a year.²

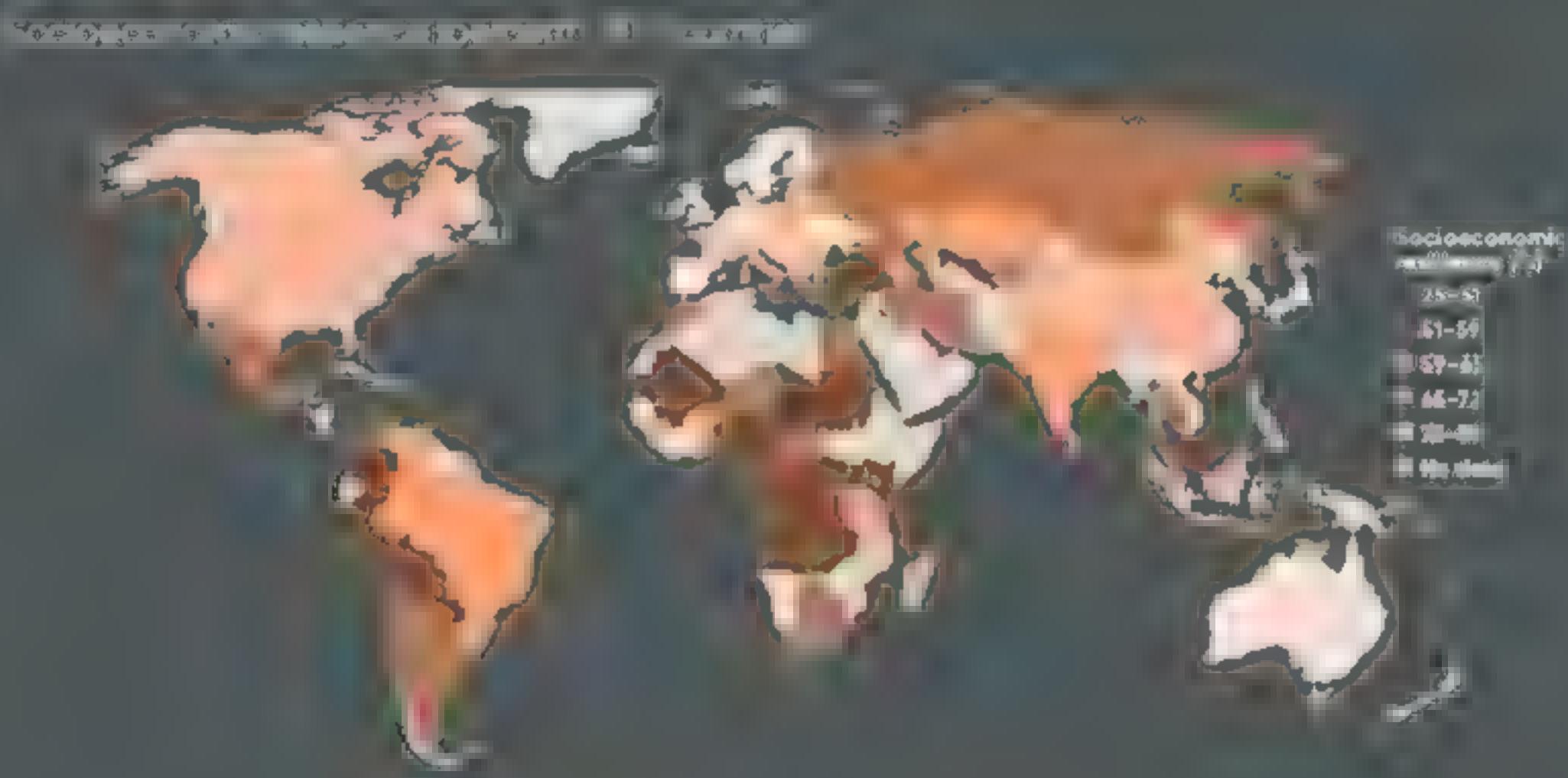
Because disaster losses are concentrated on a small share of country populations, imperfectly shared, and affect more poor people (who have limited ability to cope with them), this report estimates that well-being losses in these countries are equivalent to consumption losses 60 percent larger than asset losses, or about \$520 billion a year. Globally, poor people are disproportionately affected by these losses: people in the bottom 20 percent experience only 11 percent of total asset losses but 47 percent of well-being losses. Thus poor people experience asset losses that are only half of the average but well-being losses that are more than twice as large.

Maps O.1 and O.2 show this report's estimates of socioeconomic resilience and risk to well-being. Risk to well-being decreases with country income (figure O.2b). This decrease is driven mostly by better protection against floods, higher-quality buildings, and widespread early warning systems in wealthier countries, but resilience also matters.

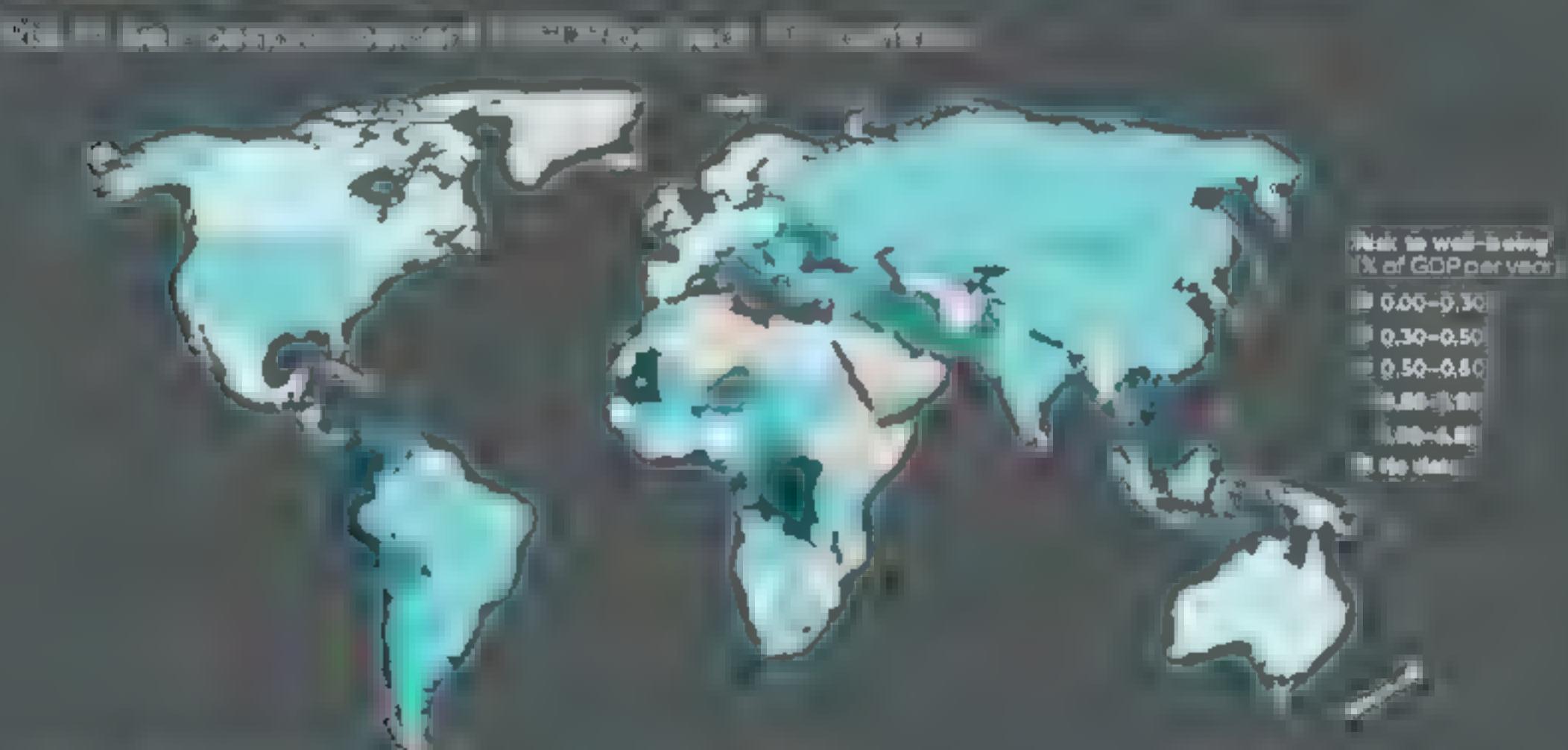
The average global socioeconomic resilience is 62 percent, ranging from 25 percent in Guatemala to 81 percent in Denmark—meaning that \$1 in asset losses in Guatemala has the same impact on well-being as a \$4 reduction in national consumption. Figure O.2a shows that, overall, resilience grows with GDP per capita.

The fact that rich countries are more resilient than poor countries is not a surprise. But resilience varies widely across countries of similar wealth because it depends on many other factors, including inequality and safety nets. Thus all countries, regardless of their geography or income, can reduce risk by increasing resilience.

Map 1.1 Socioeconomic resilience measures the ability of a population to cope with asset losses



Risk to well-being combines hazard, exposure, asset vulnerability, and socioeconomic resilience

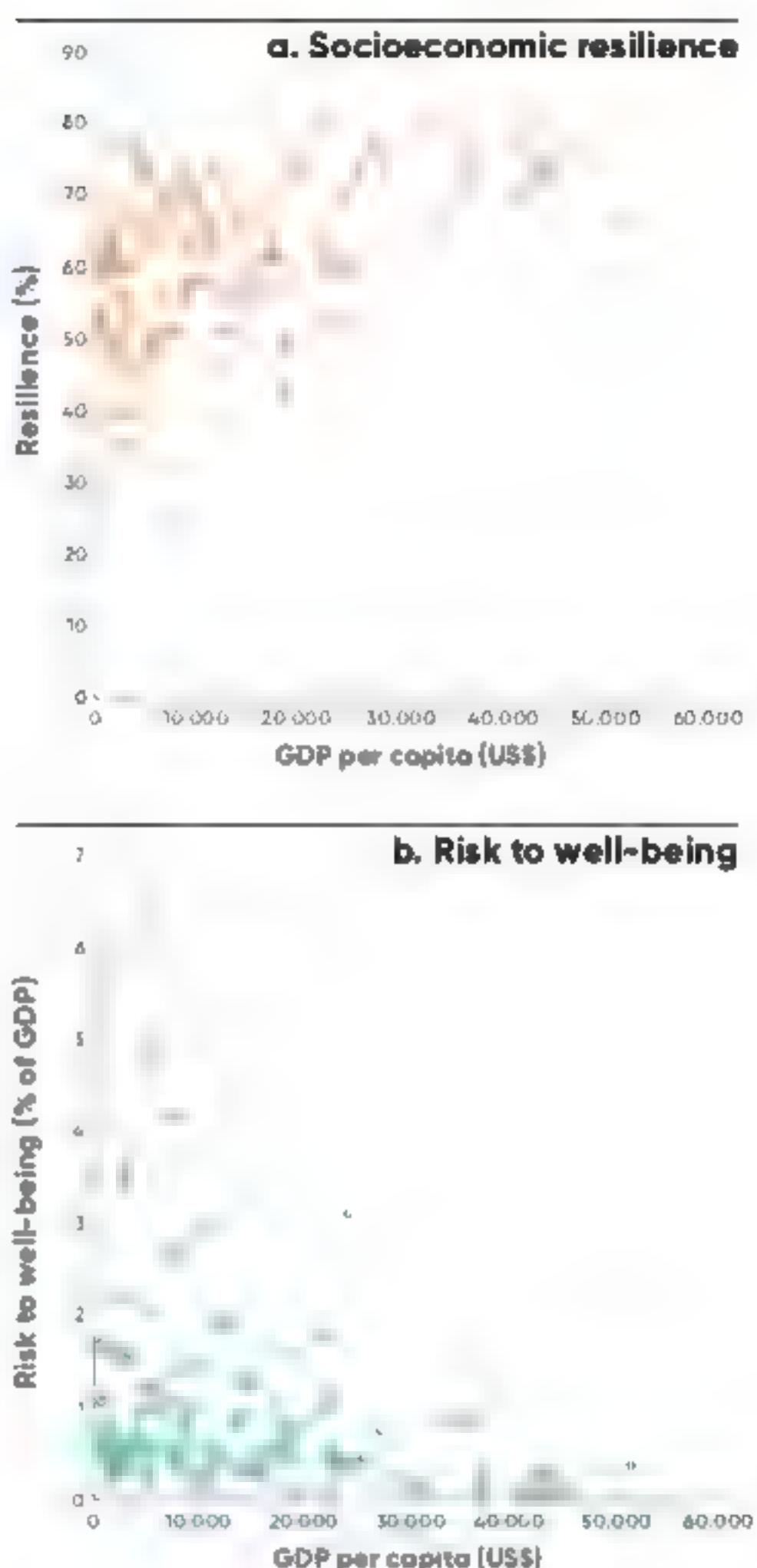


Sources: World Bank estimates

Figure O.2: Socioeconomic resilience tends to increase with income, whereas risk to well-being decreases with income

Source: World Bank estimates.

The socioeconomic resilience measure used here captures part of the United Nations' definition of resilience: the ability to resist, absorb, accommodate, and recover from the effects of a hazard in a timely and efficient manner. But it does not cover all the areas discussed in research on resilience (see Barrett and Constanas 2014; Engle et al. 2013). For example, this framework does not take into account direct human impacts (such as death, injuries, and psychological impacts), cultural and heritage losses (such as destruction of historical assets), social and political destabilization, and environmental degradation (such as when disasters affect industrial facilities and create local pollution). For a broader view of resilience, it is useful to also consider indicators that use different methodologies and other aspects of resilience (see chapter 4).



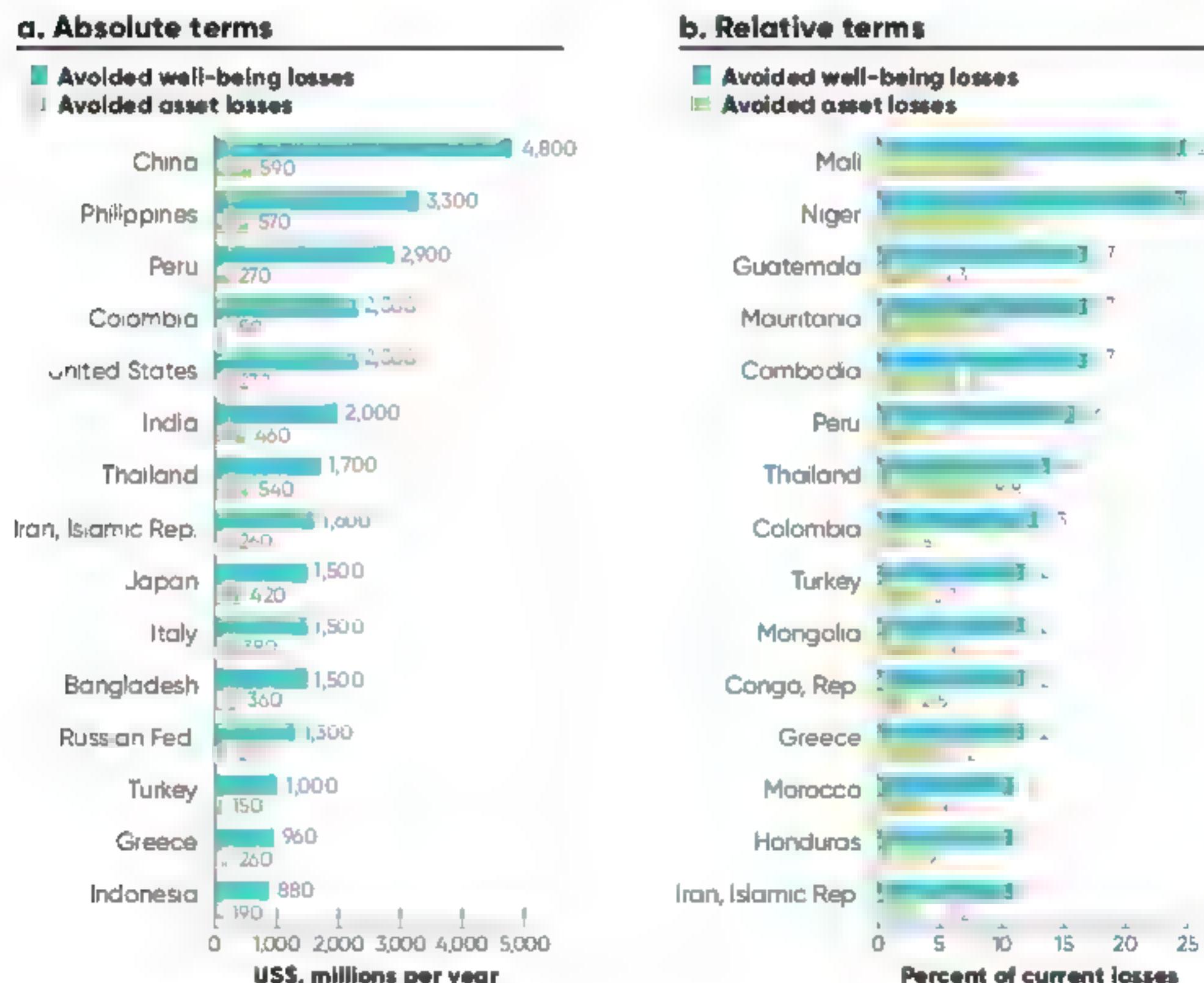
What matters is not only how much benefit a project generates, but also who benefits

To assess the potential benefits of projects that protect populations against hazards, consider two similar interventions. The first would reduce by 5 percent the share of the population exposed to natural hazards, but target only the poorest 20 percent of people in each country. If the entire world implemented this intervention, avoided asset losses would be \$7 billion a year—but global gains in well-being would be \$40 billion because the intervention would benefit poor and highly vulnerable people.

The second intervention would also reduce the share of the population exposed to natural hazards by 5 percent, but target only the top 80 percent. Because richer people have so many more assets than do the poor, avoided asset losses would be much larger—about \$19 billion. But gains in well-being would be smaller—\$22 billion.

Where would such interventions be the most attractive? In absolute terms, reducing the exposure of poor people to disasters would provide the most benefits in large and high-risk countries (figure O.3a). But in relative terms, reducing the exposure of poor people is more efficient in countries in which they have limited social protection and access to finance (figure O.3b). In such countries, resilience is low, magnifying the benefits of lower exposure. In Mali and Niger, for example, reducing exposure to natural disasters by 5 percent could cut asset losses by more than 10 percent and well-being losses by 25 percent—but only if such efforts target poor people.

Figure O.3: Reducing poor people's exposure to disasters could prevent large losses in well-being and assets



Source: World Bank estimates.

Note: The figure shows avoided annual average losses from a 5 percent reduction in exposure, achieved by reducing the exposure of the poorest 20 percent of people, expressed in absolute terms (millions of US dollars per year, adjusted for purchasing power parity) and relative terms (percentage of current average asset and well-being losses).

These results highlight the trade-offs between monetary gains and well-being gains. If a disaster risk reduction budget is allocated based only on avoided asset losses and

monetary benefits, most investments will go to rich areas. Instead, investments in disaster risk management need to balance the need for economic efficiency with the imperative to protect the most vulnerable. Measuring benefits in terms of increased well-being instead of avoided asset losses is a way to do so.

The same approach can also be applied at the subnational level to identify regional priorities within countries. For example, it can help prioritize between two similar risk reduction projects in two different provinces in Vietnam. A project that would prevent \$1 million a year in asset losses in Binh Dinh province, which has an estimated resilience of 69 percent, would generate well-being benefits valued at \$1.4 million a year (\$1 million divided by 69 percent). By contrast, a project that would prevent \$1 million a year in asset losses in Kien Giang province, which has estimated resilience of 29 percent, would increase well-being by \$3.4 million a year (\$1 million divided by 29 percent). Thus the project in Kien Giang would do far more to increase well-being.

Increasing resilience is good economics

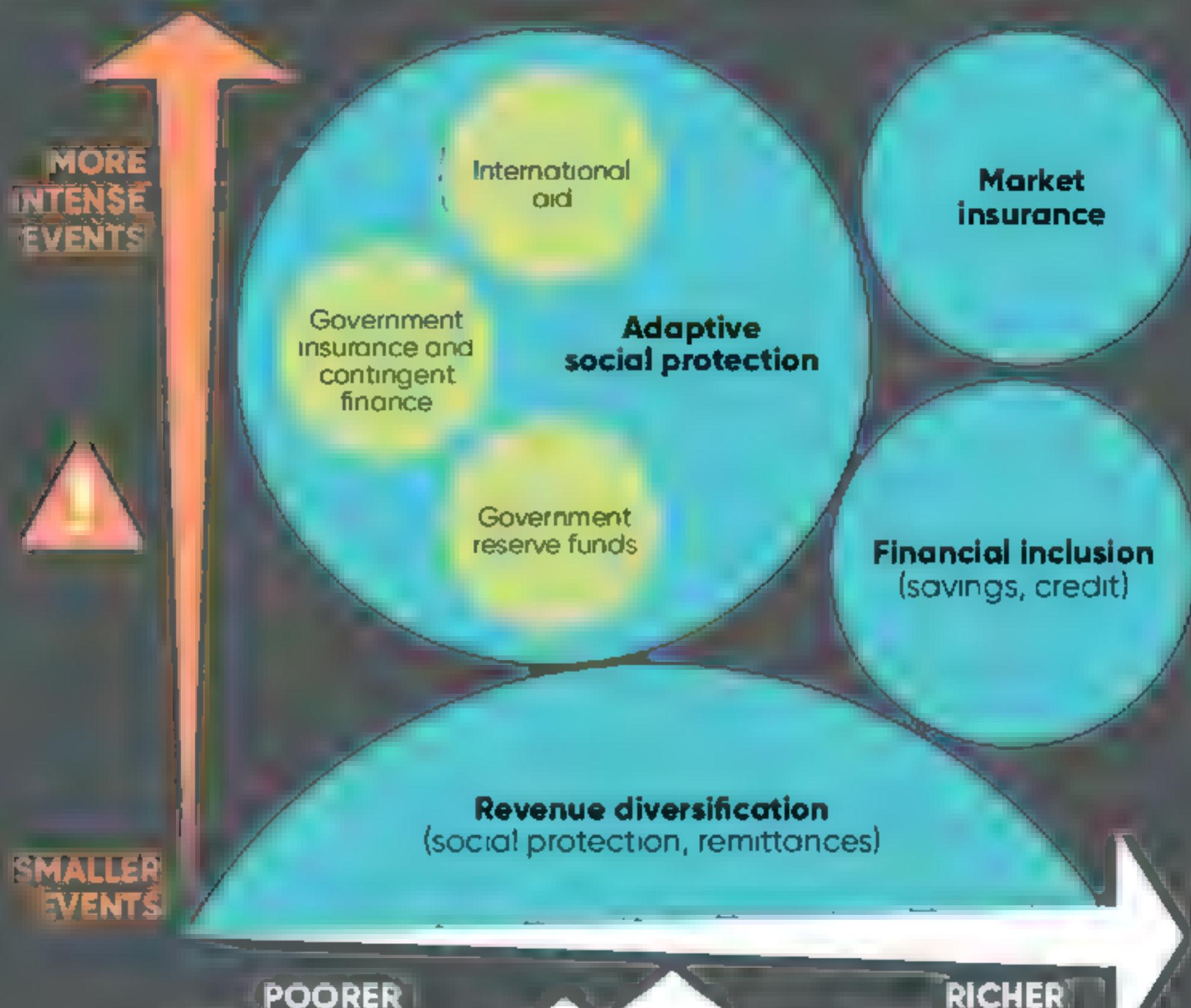
Despite efforts to reduce people's exposure to natural hazards or make their assets less vulnerable to hazards, natural risk cannot be cut to zero. Disasters will continue to occur, and they may even become more frequent because of climate change, urbanization, and increasing population densities in coastal areas. Thus it is critical to supplement actions on exposure and vulnerability with improvements in people's ability to cope with unavoidable shocks. Such efforts require a flexible, holistic risk management strategy that uses different tools for different types of disasters and populations (figure O.4).

Revenue diversification. Diversifying revenue and receiving remittances or cash transfers from social programs help households at all income levels cope with small shocks (Bandyopadhyay and Skoufias 2012). People suffer less from a local disaster if some of their income comes from outside the area through government transfers or remittances.

Financial inclusion. Financial inclusion helps poor people save in forms less vulnerable to natural hazards than in-kind savings like livestock and housing, which diversifies risk. It also enables the poor to access credit, thereby accelerating and improving recovery and reconstruction. But improving poor people's access to formal financial instruments is a long-term challenge in many developing countries and is insufficient for larger shocks.

Market insurance. Market insurance can protect against larger losses, but efforts to provide universal access to insurance face multiple obstacles, including weak

Figure O.4: Risk management should include a range of tools for different types of disasters and households



Source: Hallegatte et al. 2016

authorities' budgets

institutional and legal capacity, affordability issues, and high transaction costs—especially for poor people.

Adaptive social protection. For poor households—and to cover the largest shocks—easily scalable social safety nets are needed. Although social safety nets always improve resilience, a growing body of evidence reveals that such instruments are even more efficient when their targeting and delivery are flexible enough to transfer resources to disaster victims in a timely fashion. Postdisaster transfers have a benefit-cost ratio above 1.3 in the 117 countries studied. And in 11 countries—Angola, Bolivia, Botswana, Brazil, Central African Republic, Colombia, Honduras, Lesotho, Panama, South Africa, and Zambia—every \$1 spent on postdisaster transfers yields well-being benefits of more than \$4.

Quick action through existing social protection programs can be especially effective at preventing humanitarian emergencies and cutting intervention costs (del Ninno, Coll-Black, and Fallavier 2016). In 2015 Kenya's Hunger Safety Net Programme delivered support to more than 100,000 additional households in response to drought, and added a special transfer to 200,000 households in anticipation of expected droughts. In Ethiopia, rural farmers affected by drought in 2005 and 2011 and covered by the Productive Safety Net Programme had consumption losses 25 percent lower than those of other rural farmers (White and Porter 2016).

Disaster risk financing. These types of adaptive social protection programs create liabilities for governments, which may require them to draw on various tools such as reserve funds (for smaller disasters), contingency credit lines (such as World Bank's Cat-DDOs), regional risk pools (such as the Caribbean Catastrophe Risk Insurance Facility), or transfers of part of the risk to global reinsurance or global capital markets (such as with FONDEN bonds in Mexico) (Mahul and Ghesquiere 2007). Such tools make it possible for governments to support the affected population, and they improve the transparency and predictability of the postdisaster response (Clarke and Dercon 2016). Meanwhile, combined with institutional preparedness and contingent plans, they can accelerate recovery and reconstruction, reducing overall losses (de Janvry, del Valle, and Sadoulet 2016).

A resilience package. These instruments increase people's ability to cope with asset losses without reducing the asset losses themselves. Implemented together as part of a *resilience package*, they could reduce global well-being losses from natural disasters by \$78 billion. Adding universal access to early warning systems would raise well-being benefits to \$100 billion.

The analysis described in this report reveals the powerful complementarities between interventions, as well as the importance of designing each intervention as part of a consistent package best developed at the country level (box O.1). For example, policies that facilitate access to financial resources after disasters and interventions that make safety nets more responsive generate much larger benefits combined than the sum of the two performed independently. There is also a strong complementarity between market insurance and adaptive social protection, with insurance providing protection for the middle class while adaptive social protection is most efficient when focused on the poor.

A package of resilience-building policies would generate benefits that go beyond the avoided well-being losses estimated here and contribute to a broader development agenda.

RESILIENCE PACKAGES SHOULD BE TAILORED TO EACH COUNTRY

Figure BO.1.1: Many actions could reduce well-being and asset losses in Malawi



Source: World Bank estimates.

Note: U.S. dollars are measured in terms of purchasing power parity (PPP). Poor people are defined as the poorest 20 percent in terms of consumption in the country.

To identify promising policy options and help design consistent strategies, this report proposes disaster management profiles for the 117 analyzed countries. The profile for Malawi shows the potential benefits of different actions on well-being and asset losses (figure BO.1.1).

In Malawi, building up social protection systems so that poor people receive a larger share of their income from transfers would increase resilience and reduce the effect of natural disasters on well-being. Even if their income does not change, increasing the share of social transfers in poor people's income to 33

percent would increase resilience, thereby reducing disaster well-being losses by an average \$27 million a year. Furthermore, making social protection more adaptive and enhancing the government's ability to provide postdisaster support—by combining financial instruments and delivery mechanisms—should

generate well-being gains of nearly \$8.9 million a year

Meanwhile, reducing poor people's exposure so that total exposure is reduced by 5 percent would prevent asset losses of \$2.6 million a year and generate well-being gains of \$23 million a year. By contrast, reducing the exposure of nonpoor people would prevent much higher asset losses (\$7.1 million a year), but would provide much lower well-being benefits (\$7.4 million a year).

If only floods are considered, reducing poor people's exposure would cut asset losses by \$2.2 million a year, generating well-being gains equivalent to \$19 million a year. This finding suggests that a government could be ready to pay up to \$3,800 per poor person either protected by a dike or resettled in a safe area (with a 6 percent discount rate).

Designing interventions at the country level would require far more detailed analyses. Still, these estimates could help inspire policy makers everywhere to discuss new ways to reduce disaster impacts by identifying actions that cost less than the estimated benefits and suit a country's context and capacity.

First, disaster risk reduction can generate growth and benefits—beyond avoided losses—by promoting investment. Evaluations of the World Food Programme's R4 Rural Resilience Initiative and Mexico's CADENA program have shown that insurance is helping farmers increase their investments in productive assets, boosting their productivity (Madajewicz, Tsegay, and Norton 2013; de Janvry, Ritchie, and Sadoulet 2016). Such additional benefits from disaster risk management due to changes in people's investment and saving behaviors make risk reduction investment more profitable than avoided losses suggest.

Second, the package of resilience-building policies discussed here would deliver benefits that extend beyond the context of natural disasters: financial inclusion, access to health and nonhealth insurance, and stronger social protection shield people against all sort of shocks, facilitate investment and innovation, and promote development and poverty reduction. Again, there are obvious synergies between efforts to reduce poverty and build resilience.

Although much can be achieved by reducing asset losses from natural disasters, risk can never be eliminated. Flood protection can fail in the face of exceptional tsunamis or storm surges, and huge earthquakes can wreak massive devastation even in the face of the strictest building norms. And then there is climate change: its uncertain effects make it even more likely that some hazards will overwhelm protection infrastructure or hit where they are not expected. In this uncertain world, a more resilient population is critical to break the cycle of poverty-inducing disasters.

NOTES

- 1 The estimate for the 2015 losses is from Swiss Re. The estimate of average annual losses is from the *United Nations Global Assessment Report on Disaster Risk Reduction* (UNISDR 2015). This later estimate deviates from observations because the model and data are imperfect and because the average annual losses include the average losses from low-probability, high-impact events that have not occurred and the underreported losses from high-probability, low-impact events such as recurrent floods. All dollar amounts are U.S. dollars unless otherwise indicated.
- 2 The average annual losses are slightly higher than the ones published in the 2015 GAR report because revised estimates of the stock of capital were used in this analysis.

REFERENCES

Biez, J., I. Lucchetti, M. Salazar, and M. Genoni. 2016. "Gone with the Storm: Rainfall Shocks and Household Wellbeing in Guatemala." *Journal of Development Studies*. DOI:10.1080/00220388.2016.1224853.

Bandyopadhyay, S., and E. Skoufias. 2012. "Rainfall Variability, Occupational Choice, and Welfare in Rural Bangladesh." Policy Research Working Paper 6134, World Bank, Washington, DC.

Barrett, C. B., and M. A. Constan. 2014. "Toward a Theory of Resilience for International Development Applications." *Proceedings of the National Academy of Sciences* 111: 14625–30.

Bustelo, M. 2011. "Bearing the Burden of Natural Disasters: Child Labor and Schooling in the Aftermath of the Tropical Storm Stan in Guatemala." University of Illinois at Urbana-Champaign.

Caruso, G., and S. Miller. 2015. "Long Run Effects and Intergenerational Transmission of Natural Disasters: A Case Study on the 1970 Ancash Earthquake." *Journal of Development Economics* 117: 134–50.

Clarke, D., and S. Dercon. 2016. *Dull Disasters? How Planning Ahead Will Make a Difference*. Oxford: Oxford University Press.

Cole, S., X. Gine, J. Tobacman, P. Topalova, R. Townsend, and J. Vickery. 2013. "Barriers to Household Risk Management: Evidence from India." *American Economic Journal: Applied Economic* 5: 104–35. doi:10.1257/app.5.1.104.

Dang, H. A., P. F. Lanjouw, and R. Swinkels. 2014. "Who Remained in Poverty, Who Moved Up, and Who Fell Down? An Investigation of Poverty Dynamics in Senegal in the Late 2000s." Policy Research Working Paper 7141, World Bank, Washington, DC.

de Janvry, A., A. del Valle, and E. Sadoulet. 2016. "Insuring Growth: The Impact of Disaster Funds on Economic Reconstruction in Mexico." Policy Research Working Paper 7714, World Bank, Washington, DC.

de Janvry, A., E. Ritchie, and E. Sadoulet. 2016. "Weather Index Insurance and Shock Coping: Evidence from Mexico's CADENA Program." Policy Research Working Paper 7715, World Bank, Washington, DC.

del Ninno, C., S. Coll-Black, and P. Fallavier. 2016. *Social Protection Programs for Africa's Drylands: Social Protection Programs*. Washington, DC: World Bank.

Dercon, S. 2004. "Growth and Shocks: Evidence from Rural Ethiopia." *Journal of Development Economics* 74: 309–29.

Dercon, S., and C. Porter. 2014. "Live Aid Revisited: Long-Term Impacts of the 1984 Ethiopian Famine on Children." *Journal of European Economic Association* 12: 927–48. doi:10.1111/jeea.12088.

Engle, N. L., A. de Bremond, E. L. Malone, and R. H. Moss. 2013. "Towards a Resilience Indicator Framework for Making Climate-Change Adaptation Decisions." *Mitigation and Adaptation Strategies for Global Change* 19: 1295–1312.

Gentle, P., R. Thwaites, D. Race, and K. Alexander. 2014. "Differential Impacts of Climate Change on Communities in the Middle Hills Region of Nepal." *Natural Hazards* 74: 815–36. doi:10.1007/s11069-014-1218-0.

Hallegatte, S., M. Bangalore, L. Bonzanigo, M. Fay, T. Kane, U. Narloch, J. Rozenberg et al. 2016. *Shock Waves: Managing the Impacts of Climate Change on Poverty*. Climate Change and Development Series. Washington, DC: World Bank.

Hallegatte, S., M. Bangalore, and A. Vogt-Schilb. Forthcoming. "Socioeconomic Resilience to Multiple Hazards—An Assessment in 117 Countries." Background paper prepared for this report, World Bank, Washington, DC.

Kousky, C. 2016. "Impacts of Natural Disasters on Children." *Future of Children* 73–92.

Madajewicz, M., A. H. Tsegay, and M. Norton. 2013. *Managing Risks to Agricultural Livelihoods: Impact Evaluation of the Harita Program in Tigray, Ethiopia, 2009–2012*. London: Oxfam.

Mahul, O., and F. Ghesquiere. 2007. "Sovereign Natural Disaster Insurance for Developing Countries: A Paradigm Shift in Catastrophe Risk Financing." Policy Research Working Paper 4058, World Bank, Washington, DC.

ODI (Overseas Development Institute) and GFDRR (Global Facility for Disaster Reduction and Recovery). 2015. "Unlocking the Triple Dividend of Resilience—Why Investing in DRM Pays Off." <http://www.odi.org/tripledividend>.

Rozenberg, J., and S. Hallegatte. Forthcoming. "Model and Methods for Estimating the Number of People Living in Extreme Poverty Because of the Direct Impacts of Natural Disasters." Background paper prepared for this report, World Bank, Washington, DC.

UNISDR (United Nations Office for Disaster Risk Reduction). 2015. *United Nations Global Assessment Report on Disaster Risk Reduction*. Geneva: UNISDR.

White, E. J., and C. Porter. 2016. "Potential for Application of a Probabilistic Catastrophe Risk Modelling Framework to Poverty Outcomes: General Form Vulnerability Functions Relating Household Poverty Outcomes to Hazard Intensity in Ethiopia." Policy Research Working Paper 7717, World Bank, Washington, DC.

*¹ Economic losses from natural disasters totaled \$92 billion in 2015.**

Such statements, all too commonplace, assess the severity of disasters by no other measure than the damage inflicted on buildings, infrastructure, and agricultural production. But \$1 in losses does not mean the same thing to a rich person that it does to a poor person; the gravity of a \$92 billion loss depends on who experiences it. By focusing on aggregate losses—the traditional approach to disaster risk—we restrict our consideration to how disasters affect those wealthy enough to have assets to lose in the first place, and largely ignore the plight of poor people.

This report moves beyond asset and production losses and shifts its attention to how natural disasters affect people's well-being. Disasters are far greater threats to well-being than traditional estimates suggest. This approach provides a more nuanced view of natural disasters than usual reporting, and a perspective that takes fuller account of poor people's vulnerabilities.

Poor people suffer only a fraction of economic losses caused by disasters, but they bear the brunt of their consequences.

Understanding the disproportionate vulnerability of poor people also makes the case for setting new intervention priorities to lessen the impact of natural disasters on the world's poor, such as expanding financial inclusion, disaster risk and health insurance, social protection and adaptive safety nets, contingent finance and reserve funds, and universal access to early warning systems.

Efforts to reduce disaster risk and poverty go hand in hand. Because disasters impoverish so many, disaster risk management is inseparable from poverty reduction policy, and vice versa.

As climate change magnifies natural hazards, and because protection infrastructure alone cannot eliminate risk, a more resilient population has never been more critical to breaking the cycle of disaster-induced poverty.

Reference Control:

cc2bedadb44fd3a0e70d8b4f78874c5c6c942e3923b1baa6f59b8bf6b5a783ef31cf8c27
c41409b329b269baa70498effd807dabab7e0194975504c7c81f6a7da2433adc1ea770
45ff99d8c75aa0279ff58a63baf1015089aa550e0d63188125c5aa6e7c1f117dfa84f36fc
67e7a026e2ecb8a844aadad39a90084a14287eb59